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Scott, therefore, we may deduce with some assurance certain data about Antarctic weather conditions which must inevitably be taken into account in future voyages of exploration to the Antarctic regions. In fact, on the strength of these deductions, a guess may now be hazarded. Lieutenant Filchner is probably wintering somewhere under the lee of Coats Land. For aught we know to the contrary, there may be another range of mountains there pointing towards the South Pole; at any rate, it seems probable that Filchner will have better weather than either Nordenskjöld or Scott, and that this may aid him in breaking a new trail to the South Pole.

SOME GEOGRAPHIC RELATIONS ILLUSTRATED IN THE PRACTICE OF AGRICULTURE*

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The geography underlying agriculture may be viewed from two contrasted viewpoints. The larger problem is of course to consider the distribution of crops in a unit area as related to the climate, surface features, soil, labor supply and markets. For instance, with the climate, surface features and soil all favoring the development of dairying in a given section, whether that dairying shall be for furnishing fresh milk or for making butter or cheese, depends generally on the character and accessibility of the market. The distribution of wheat in the United States is dependent very largely on certain conditions of climate and soil, and the distribution of maize for food is dependent on the same conditions but with varying ratio between the values of the determinants.

The more detailed relations between agriculture and physical conditions, however, are equally interesting and perhaps at first sight less obvious. They are none the less real and important, however. Some of these relations, as seen in agricultural practice in the eastern United States, form the basis of this paper.

Slope and Exposure. In any region of varied relief, with contrasted slopes and exposure to sunlight and wind, agricultural operations must be adjusted according to the slope conditions. The distribution of hand versus machine operations in plowing, tillage and harvesting is largely a question of slope, though in the glaciated section of New England, the stony and ledgy character of the soil determines in many cases the form of tillage operations. The persistence of hand work in plowing, cultivating and harvesting of crops, like corn and potatoes, in New England is due in part to the small average size of the farms and in part to the steepness and irregularity of the slopes.

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Here in general we find the gentler slopes devoted to tilled crops, the steeper slopes to fruit and the rougher regions to pasturage, scrub land and forests. Cattle can more cheaply and profitably harvest the natural crops of land nearly covered with boulders and with steep slopes, than can man either by hand or machine labor.

In any rugged or even rolling region, the question of water drainage and direction and rate of ground water movement is a vital matter from the crop standpoint. Farmers now generally recognize the importance of drainage as related to well or spring water supply, to the building of storage houses and in similar matters, but few yet realize that there is, in any region of varied relief, an air drainage as regular and as easily determined as is the water drainage. Houses on hillsides, if with the right exposure, will enjoy more air movement, both by day and night in the summer, than those located on hilltops or in valley bottoms. Furthermore, the extremes of temperature in summer or in winter are less on hillsides than in valley bottoms. This is the factor generally recognized by extensive market gardeners who fear the effects of early frosts or low nocturnal temperatures on the lower slopes in rugged regions.

In the northeastern United States the prevailing winter wind is from some point of the northwest and the prevailing summer wind is from the southwest, except in narrow and elongated valleys, where the lower currents are more or less influenced in their direction by the alignment of the surface features. Few farmers, however, realize the persistence of wind directions and pay little attention to this matter in the location of farm buildings or houses.

The question of exposure to sunlight is an important matter in gardening and fruit culture. In small gardens with many different crops, some naturally tall and some low in height, the rows should run north and south so that the tall crops will not shade the lower-lying plants, except for a few hours in the day. Plants raised in north and south rows will grow more symmetrically than those raised in east and west rows, because the plants receive equal hours of sunlight on both sides and, furthermore, during the hottest hours before and after noon are less exposed to the intense sun's rays than they would be if planted in east and west rows.

Similarly the matter of exposure to sunlight explains why the best fruit is usually found in the higher parts of a tree, and why the next best is found on the south and southwest sides.

It is a commonly recognized principle that early and less hardy fruit trees should, in the Northern Hemisphere, be planted on north facing slopes, because such slopes are nearly tangential to the sun's rays during the midday hour, or may even be in the hill shadow while southern slopes may be nearly perpendicular to the sun's rays. Hence south slopes favor the early starting of trees, while northern slopes retard it, an important consideration in fruit culture in regions where the temperature may rise unseasonably high in the winter months and thus prematurely start the sap in delicate fruit trees.

Shade trees on the south side of tilled fields, though they may have their artistic value, are economically an unwise investment because of the effect of shade during the hours of the growing season, between 6 A.M. and 6 P.M. Field crops planted in the shade of east and west rows of trees are rarely successful, but those in the shade of north and south rows are somewhat more successful, for the influence of the shade is felt for less hours. Gardens sheltered from early morning sun, however, are always backward and disappointing.

The question of exposure is also a vital matter to be taken into consideration in the construction of farm outbuildings, as is recognized in certain cases. Cattle yards, sheep yards and hog runs ought naturally to be on the south side of buildings, or windbreaks, and at the same time protected from the northerly and westerly fair weather winter winds. Protection from the northeasterly and easterly winds is less significant, because these are usually storm winds, and stock will be kept under cover during storms.

The alignment of cow barns, horse stables, hog houses and hen houses ought to be considered from the standpoint of sun as well as wind exposure. Cow barns, planned for a double row of animals, should run in a north and south direction, so as to get the advantage of both the east and west exposures to sunlight. Henhouses, as ordinarily constructed, should run east and west so as to bring the scratching floors on the south side. Hog houses and cattle barns should be constructed so as to have the windows at the proper height, according to latitude, for securing the maximum amount of sunlight in the short days of midwinter. Improperly placed windows may cut off all the sunlight from the stock or pens, when a proper consideration of the height of windows above the base line will throw the sun's rays where they are of most value. Some breeders of hogs prefer to have their windows adjusted so as to throw the light into the pens about the times of the equinoxes, which are the farrowing times for hogs.*

The much debated question as to whether it is desirable to have cattle in a double rowed stable face inward or outward, is not usually considered sufficiently from the standpoint of exposure to sunlight. Cattle facing inward in a north-south barn, with windows properly adjusted as to height, will receive the sunlight on their bodies rather than their heads and will not have their eyes exposed to such a strong glare as will animals facing outward. The question of exposure to light is equally important in horse stables, but usually horses are made to face the windows, an unfortunate arrangement from the standpoint of eyesight, warmth and comfort, particularly in the winter months.

Seasonal Weather Conditions. In general, successful crops during any year are roughly declared to be the effects of good weather and bad crops of bad weather, but few stop to analyze the special seasonal conditions that affect the crops or to consider what extremes of weather may be expected and whether the farmer can in any way be forearmed to meet such conditions.

Any locality is limited in its crop variety by the length of the growing season, which extends, for the main crops, from the date of the last killing frost in the spring to that of the earliest frost of autumn. Of course the length of the growing season varies with the latitude, altitude and position of a given region in reference to the ocean. Some years the growing season is several weeks longer than usual and in others it is shorter than the average, but the main crops in general are planted at about the same time each year and harvested at about the same date.

But the quality of a crop, and the quantity as well, are largely determined by possible variants within the growing season established on the basis of temperature alone. The seasonal distribution of sunshine and cloudiness may have a large effect on crops, and can not be anticipated or guarded against. The growth of corn, for instance, requires warmth and moisture directly following planting, but the character of the crop is determined by the daily temperature and sunlight during the season of rapid growth, previous to the blooming of the corn. A warm July and August with an abundance of sunlight means taller stocks, better setting of ears and a large yield, while a cool and cloudy period at this season means the reverse. Warmth and moisture at or just after the season of blooming of potatoes means, as a rule, that more tubers will set and mature. A dry season at this time, no matter what the conditions during the rest of the season, means a light crop. Similarly the saying, "A wet May means long hay," has its truth, for plenty of moisture in the season of maximum growth followed by clear skies and seasonable temperatures, means not only a heavy crop of hay, but an early maturing crop and the right conditions for harvesting in the best condition.

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* For fuller consideration of this question, with tables showing height of windows for different seasonal exposures and different latitudes, see *Farmers' Bulletin*, 438 U. S. Dept. of Agric.

A dry summer, immediately following the haying season, is unfavorable for the renewed growth of the grass, makes summer seeding of hay lands uncertain in results and causes a great loss of ground water from the soil by evaporation, because of the lack of a vegetation blanket on hayfields that would retard the rate of loss of ground water. Many other illustrations might be given of this intimate relation between sunshine, cloudiness, distribution of rainfall and success of crops.

Changes of weather conditions also affect animals in many ways worth noting. In the summer months where dairy cows are pastured in the ordinary wild pasture, they have to keep working to get as much food as is necessary for the greatest efficiency. Ordinarily cows will eat most freely in the early morning, in the late afternoon and on moonlight nights, if the weather is of the ordinary temperature and humidity. But on over warm and over humid days, cows will seek shade, and will not eat until driven to do so by hunger, and then they will eat sparingly. The indirect result of the excessive humidity is at once seen in the reduced flow of milk.

The same thing is true in the winter when cows are stalled and their food supply is regulated and constant. Where twice daily records are kept of the output of individual members of a herd, it will be found that the herd as a whole, and nearly every individual, will vary in amount of milk produced according to weather conditions, when the amount of food, the care, and other surrounding conditions are kept as nearly as possible unchanged. There seems to be a very direct relation between milk flow and excessive humidity, at both high and low temperatures. The flow will decrease more at times of severe cold and high percentage of humidity, than when the humidity is low and the temperature unusually severe. This is probably due to the well known fact, experienced by us all, that it takes more energy to keep warm on cold, damp days than on much colder, dry days. In consequence of this extra demand on the energy of the cow to keep warm, there is less energy left for milk producing. Changes of humidity and temperature also seem to affect the efficiency of other animals, but it is not as easy to measure the results quantitatively, as is possible in a dairy herd.

Ground Water. The one element that is most vital to most crops is of course the ground water, whether it is at a high or low level and whether it can be supplied at the necessary rate for the growth of a given crop. The amount of water needed by various crops differs, and the depths from which crops can secure ground water also vary. Alfalfa, for instance, is deep rooted and especially adapted to countries where the ground water level is low. It is developed, therefore, with difficulty in heavy soils so situated that the ground water level is near or at the surface during many months in the year. Corn on the other hand is shallow rooted and the level of the ground water must be kept within reach of the roots. Hence the necessity of more tillage for corn and similar crops in dry seasons than in moist seasons. The methods of dry farming give any farmer the rule to adopt in crop management during dry seasons.

If the ground water level tends to lower, it must be retained near the surface by mulches or tillage. Conversely, if the ground water tends to remain too near the surface so that the land becomes saturated and cold, rolling and packing of the soil must be undertaken in order to increase the rate of evaporation from the surface of the ground.

The level of the ground water will rise in the autumn after a dry summer, without any rainfall because of the decreased evaporation with the lowering of the angle of the sun's rays. On this fact often depends the raising of the level of wells, the germination of fall cover crops and similar phenomena. Tillage is largely a question of maintaining suitable ground water conditions although it is not usually so considered. The method of tillage must therefore vary with the character of the season, and crops should be planted in soils where the physical conditions favor an average ground water level adjusted to the crop needs. In case of departure from mean conditions, systems of tillage must be adopted to counteract the unusual conditions.

Successful crop raising is largely a question of soil and ground water management in which, as has been illustrated by these scattered instances based on experience, geography has a large place, whether the geographic relation is so recognized or not.